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Age and Sex Disparities in Cardiovascular Risk Factor Management prior to Stroke: Linked Registry and General Practice Data

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Keywords
Cardiovascular risk factors · Healthcare disparities · General practice · Primary health care · Primary prevention · Stroke

Abstract
Introduction: There is limited evidence about the management of cardiovascular risk factors within 12 months before stroke or transient ischaemic attack (TIA) in Australian general practices. We evaluated whether age and sex disparities in cardiovascular risk factor management for primary prevention exist in general practice. ***Methods:*** A retrospective cohort study using data from the Australian Stroke Clinical Registry (2014–2018) linked with general practice data from three Primary Health Networks in Victoria, Australia. We included adults who had ≥2 encounters with a general practitioner within 12 months immediately before the first stroke/TIA. Cardiovascular risk factor management within 12 months before stroke/TIA was evaluated in terms of: assessment of risk factors (blood pressure [BP], serum lipids, blood glucose, body weight); prescription of prevention medications (BP-lowering, lipid-lowering, glucose-lowering, antithrombotic agents); and attainment of risk factor targets. ***Results:*** Of 2,880 patients included (median age 76.5 years, 48.4% women), 80.9% were assessed for BP, 49.9% serum lipids, 46.8% blood glucose, and 39.3% body weight. Compared to patients aged 65–84 years, those aged <65 or ≥85 years were less often assessed for risk factors, with women aged ≥85 years assessed for significantly fewer risk factors than their male counterparts. The most prescribed prevention medications were BP-lowering (64.9%) and lipid-lowering agents (42.0%). There were significant sex differences among those aged <65 years (34.7% women vs. 40.2% men) and ≥85 years (34.0% women vs. 44.3% men) for lipid-lowering agents. Risk factor target attainment was generally poorer in men than women, especially among those aged <65 years. ***Conclusion:*** Age-sex disparity exists in risk factor

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management for primary prevention in general practice, and this was more pronounced among younger patients and older women.

Introduction

Stroke is a leading cause of death and disability in Australia [1] and globally [2]. The burden of stroke is predicted to double by 2050 in Australia [3]. Over 80% of strokes can be prevented with effective management of cardiometabolic risk factors, e.g., blood pressure (BP), serum lipids, and blood glucose [4]. Therefore, it is recommended in Australian clinical guideline that adults undertake routine assessment and management of these risk factors to prevent stroke, transient ischaemic attack (TIA) or other cardiovascular diseases (CVDs) [5]. For example, lowering BP alone could reduce the incidence of stroke or TIA by 27% [6].

In Australia, Canada, and several European countries, general practitioners (GPs) have a central role in the delivery and coordination of primary care [7–9]. Governments of these countries provide financial incentives to support GP-led prevention or management of chronic disease (e.g., diabetes, hypertension) in the community. These incentivised policies often involve routine comprehensive assessment of risk factors in patients with multimorbidity or at high risk of adverse events. In Australia, there are financial incentives available to GPs through the universal health insurance scheme (Medicare), to support routine assessment of risk factors in people with chronic conditions [8–10]. However, there are limited contemporary data on the management of risk factors as part of effective person-centred primary prevention strategies in Australian general practice among those who subsequently have a stroke or TIA. Furthermore, it is unclear whether cardiovascular risk factor management differs by important demographic factors, such as age and sex.

In this study, we evaluated the primary prevention management of risk factors in Australian general practices among patients who subsequently had a stroke or TIA, and whether management differed by age or sex.

Methods

Study Design, Setting, and Data Sources

This was a retrospective cohort study of adults with a first-ever acute stroke or TIA between 2014 and 2018, identified from the Australian Stroke Clinical Registry (AuSCR) [11]. The AuSCR is a national stroke clinical quality registry designed to routinely monitor the quality of acute care and outcomes following a stroke/TIA. Person-level data from the AuSCR were linked with de-identified Population-Level Analysis and Reporting (POLAR) general practice data [12]. The general practice-sourced data were collected by Outcome Health (data custodian), with permission of the participating Primary Health Networks (PHNs) (online suppl. Table 1; for all online suppl. material, see https://doi.org/10.1159/000538067).

Patients were eligible for this analysis if they were aged ≥18 years and had attended any of the consenting general practices in Eastern Melbourne, South Eastern Melbourne, or Gippsland PHNs in Victoria, Australia, within 12 months immediately before the acute event (observation period). To maximise the potential for identifying a patient's regular GP, analyses were limited to patients with two or more encounters with the same general practice during the observation period. To avoid multiple GP encounters related to the same episode of care, any encounter occurring within 14 days of the previous encounter was considered a single GP encounter [13]. The number of encounters was defined as the number of days a patient had a record of GP service during the observation period. Encounters for administrative or surgical procedures, pregnancy-related care, eating disorders, and mental health (based on Medicare Benefits Schedule [Medicare] billing codes) [14] were excluded. Patients with a prior history of stroke/TIA recorded in the AuSCR and those with missing data on residential postcode were also excluded.

Evaluation of Risk Factor Management

The management of cardiovascular risk factors was evaluated within the observation period guided by contemporary guideline-recommended processes [5]. *Risk factor assessment* was inferred based on recordings of point-of-care measurements (BP and body weight) or results of pathology tests (serum lipids and blood glucose). *Prescription of recommended prevention medication among those with indications* (i.e., BP-lowering, lipid-lowering, glucose-lowering, antithrombotic agents) was ascertained from documentation of medium-level World Health Organization Anatomic and Therapeutic Classification codes [15]. *Attainment of risk factor targets* was based on the final measurement of each risk factor documented during the observation period and was defined based on the Australian clinical guidelines for absolute cardiovascular disease risk management (online suppl. Table 2) [5].

Covariates

Covariates were obtained from both POLAR and AuSCR datasets (online suppl. Table 1). Socio-economic advantage was defined based on quintiles of postcode-based Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) [16]. Comorbidities were determined based on historical diagnoses prior to the stroke/TIA event, which were coded using Systematised Nomenclature of Medicine-Clinical Terms Australian Use (SNOMED CT-AU) [17] and converted to International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian Modification (ICD-10-AM) codes, using the SnoMAP online tool [18].

Statistical Analysis

Patient characteristics were summarised using descriptive statistics and compared using Kruskal-Wallis or χ^2 tests. Multi-level logistic regression models, adjusted for all covariates (online suppl. Table 1) and clustering within general practices, were used to determine associations of age and sex with proportions of patients assessed for risk factor assessment, prescription of medications, and attainment of risk factor targets. This involved determining any non-linear relationships of age and any statistical interactions between age and sex. For the prescription of prevention medications, analyses were restricted to only patients with a clinical indication for prescription, e.g., analysis of prescription of BP-lowering agents were restricted to patients with a documented diagnosis of hypertension. Poisson regression was used to model any significant interaction between age and sex in the association with the number of risk factors assessed or medication classes prescribed. Where statistical interactions existed, analyses were stratified by age (i.e., <65, 65–74, 75–84, and ≥85 years). Results of Poisson regression models were reported in terms of incidence rate ratio with a corresponding 95% confidence interval. A two-sided p value of ≤0.05 was considered statistically significant. All statistical analyses were performed using Stata/SE 16 12.1 (StataCorp 2019).

Results

Patient Flow and Baseline Characteristics

Of 7,160 AuSCR registrants with records of GP service in POLAR, only 4,161 (58.1%) had GP service records in the 12 months immediately before their first-ever stroke/TIA. Of patients with GP service records, 2,880 (40.2%) were eligible. Patients were excluded mostly due to missing GP service records within the observation period (online suppl. Fig. 1). Among patients with GP service records, those included for analysis (n = 2,880) were significantly younger and more often women than those excluded (n = 1,282) (online suppl. Table 3). The median age of included patients was 76.5 years (interquartile range [IQR] 67.2–84.5 years; one in five were aged <65 years), 1,394 (48.4%) were women, and 1,729 (65.7%) had ischaemic stroke (Table 1). In the 12 months prior to the stroke/TIA, the included patients had a median of 6 GP encounters (IQR 4–8) overall, and by sex. The median time from the last GP encounter to the onset of stroke/TIA was 19 days (IQR 6–52). This time varied significantly by sex, being on average longer in men than women, and longer in those aged 65–74 years than other age groups.

Patient characteristics were generally similar between sexes in each age group (Table 1). Exceptions were that, among those aged <65 years, men more often belonged to a greater socioeconomic quintile (58.7% in IRSAD Quintiles 4 and 5) than women (48.2%). Overall, 88.9% of patients had at least one risk factor assessed in general practice within 12 months immediately before stroke/TIA. Of the registry cohort analysed, 705/2,880 (24.5%) had no records of any traditional risk factor (i.e., hypertension, diabetes, atrial fibrillation, dyslipidaemia, and smoking) in the general practice as of the time of admission for stroke/TIA. There were no significant sex differences between patients with no records (vs. those with records) of traditional risk factors (p value >0.05). However, patients with no records of traditional risk factors were significantly younger (median age 70.8 years, IQR 57.5–80.0) than those with records of traditional risk factors (median age 78.1 years, IQR 69.1–85.6; p value <0.001). More than half (58.6%) of the patients had hypertension, significantly more prevalent in men than women. Among those aged <85 years, a history of CVD was more prevalent among men than women, while across all age groups, women more often had a reported history of anxiety or depression than men (Table 1).

Risk Factor Assessment

Each patient was assessed for a median of two risk factors (IQR 1–3) within the 12 months immediately before the stroke/TIA. The most assessed risk factors were BP (80.9%) and serum lipids (49.9%), regardless of age or sex. In adjusted analyses, proportions of patients assessed for serum lipids, blood glucose, and body weight were generally greater among men than women. For BP, serum lipids, and blood glucose, there was a significant quadratic (U-shaped) trend in proportions of patients assessed for the risk factor with increasing age (p value <0.001; shown in Fig. 1a, b). Specifically, the lowest proportions of patients assessed for risk factors were those aged <65 and ≥85 years for both men and women. Similar patterns were observed when the total number of risk factors assessed per patient was modelled (Table 2).

Among those aged <65 years, after adjusting for age within these age categories, more women had their BP assessed than men (82.1% for women vs. 77.2% for men), while the reverse was observed among those aged ≥85 years (73.7% for women vs. 78.6% for men; p value <0.05). Similarly, among those aged ≥85 years, more men had serum lipids assessed than women (29.3% for women vs. 40.8% for men; p value <0.05), while in

Table 1. Patient characteristics by age and sex

Variables	Overall			<65 years (n = 604)		65–74 years (n = 715)		75–84 years (n = 871)		≥85 years (n = 690)	
	total	men	women	men	women	men	women	men	women	men	women
Total	2,880	1,486 (51.6)	1,394 (48.4)	336 (55.6)	268 (44.4)	428 (59.9)	287 (40.1)	462 (53.0)	409 (47.0)	260 (37.7)	430 (62.3)
Median age (IQR) at stroke onset in years	76.5 (67.2, 84.5)	**74.6 (66.3, 82.7)**	**78.7 (68.6, 86.7)**	**57.5 (50.2, 61.0)**	**55.1 (45.7, 60.6)**	70.7 (68.2, 72.7)	70.7 (68.2, 73.0)	80.0 (77.6, 82.7)	80.3 (77.7, 82.4)	**88.4 (86.7, 90.9)**	**89.3 (87.2, 92.6)**
Median days (IQR) from last GP encounter to stroke onset	19 (5, 52)	**22 (7, 55)**	**17 (5, 49)**	30 (8, 78)	26 (7, 71)	**28 (9, 66)**	**19 (5, 53)**	18 (7, 44)	16 (5, 42)	15 (5, 38)	14 (5,42)
Regional location	443 (15.4)	230 (15.5)	213 (15.3)	44 (13.1)	42 (15.7)	81 (18.9)	53 (18.5)	73 (15.8)	61 (14.9)	32 (12.3)	57 (13.3)
Median number of GP encounters (IQR)	6 (4, 8)	**6 (3, 8)**	**6 (4, 8)**	5 (3, 7)	4 (3, 7)	**5 (3, 7)**	**6 (4, 8)**	6 (4, 8)	6 (4, 8)	7 (5, 9)	7 (4, 9)
Socioeconomic advantage											
Quintile 1 (least advantaged)	341 (11.8)	175 (11.8)	166 (11.9)	**41 (12.2)**	**42 (15.7)**	62 (14.5)	36 (12.5)	49 (10.6)	47 (11.5)	23 (8.9)	41 (9.5)
Quintile 2	266 (9.2)	126 (8.5)	140 (10.0)	**25 (7.4)**	**37 (13.8)**	46 (10.8)	31 (10.8)	35 (7.6)	35 (8.6)	20 (7.7)	37 (8.6)
Quintile 3	525 (18.2)	281 (18.9)	244 (17.5)	**73 (21.7)**	**60 (22.4)**	80 (18.7)	55 (19.2)	90 (19.5)	63 (15.4)	38 (14.6)	66 (15.4)
Quintile 4	693 (24.1)	360 (24.2)	333 (23.9)	**100 (29.8)**	**65 (24.3)**	88 (20.6)	77 (26.8)	107 (23.2)	112 (27.4)	65 (25.0)	79 (18.4)
Quintile 5 (most advantaged)	1,055 (36.6)	544 (36.6)	511 (36.7)	**97 (28.9)**	**64 (23.9)**	152 (35.5)	88 (30.7)	181 (39.2)	152 (37.2)	114 (43.9)	207 (48.1)
Diagnosis											
Ischaemic	1,729 (65.7)	917 (67.3)	812 (64.0)	207 (68.1)	151 (63.7)	255 (64.4)	159 (61.4)	291 (68.5)	237 (62.4)	164 (68.9)	265 (67.6)
Intracerebral haemorrhage	329 (12.5)	153 (11.2)	176 (13.9)	33 (10.9)	29 (12.2)	37 (9.3)	34 (13.1)	53 (12.5)	59 (15.5)	30 (12.6)	54 (13.8)
TIA	508 (19.3)	264 (19.4)	244 (19.2)	54 (17.8)	50 (21.1)	94 (23.7)	56 (21.6)	75 (17.7)	76 (20.0)	41 (17.2)	62 (15.8)
Undetermined	65 (2.5)	29 (2.1)	36 (2.8)	10 (3.3)	7 (3.0)	10 (2.5)	10 (3.9)	6 (1.4)	8 (2.1)	<5	11 (2.8)
Unable to walk on admission[a]	1,704 (59.2)	**838 (56.4)**	**866 (62.1)**	162 (48.2)	136 (50.8)	209 (48.8)	151 (52.6)	279 (60.4)	265 (64.8)	188 (72.3)	314 (73.0)
Have no traditional risk factors[b]	705 (24.5)	364 (24.5)	341 (24.5)	134 (39.9)	117 (43.7)	102 (23.8)	84 (29.3)	89 (19.3)	80 (19.6)	39 (15.0)	60 (14.0)
Comorbidities[c]											
Hypertension	1,688 (58.6)	**833 (56.1)**	**855 (61.3)**	139 (41.4)	101 (37.7)	239 (55.8)	164 (57.1)	286 (61.9)	267 (65.3)	**169 (65.0)**	**323 (75.1)**
Diabetes	823 (28.6)	**478 (32.2)**	**345 (24.8)**	88 (26.2)	63 (23.5)	142 (33.2)	78 (27.2)	**166 (35.9)**	**111 (27.1)**	**82 (31.5)**	**93 (21.6)**
Atrial fibrillation	524 (18.2)	257 (17.3)	267 (19.2)	19 (5.7)	15 (5.6)	61 (14.3)	32 (11.2)	100 (21.7)	84 (20.5)	77 (29.6)	136 (31.6)
Dyslipidaemia	1,037 (36.1)	518 (34.9)	519 (37.2)	84 (25.0)	68 (25.4)	162 (37.9)	103 (35.9)	172 (37.2)	174 (42.5)	100 (38.5)	174 (40.5)
Cardiovascular disease[d]	587 (20.4)	**350 (23.6)**	**237 (17.0)**	**46 (13.7)**	**15 (5.6)**	**93 (21.7)**	**33 (11.5)**	**124 (26.8)**	**70 (17.1)**	87 (33.5)	119 (27.7)
Obesity	52 (1.8)	23 (1.6)	29 (2.1)	12 (3.6)	13 (4.9)	7 (1.6)	6 (2.1)	<5	8 (2.0)	<5	<5
Kidney disease	243 (8.4)	118 (7.9)	125 (9.0)	11 (3.3)	7 (2.6)	21 (4.9)	9 (3.1)	54 (11.7)	47 (11.5)	32 (12.3)	62 (14.4)

Table 1 (continued)

Variables	Overall			<65 years (n = 604)		65–74 years (n = 715)		75–84 years (n = 871)		≥85 years (n = 690)	
	total	men	women	men	women	men	women	men	women	men	women
Liver disease	134 (4.7)	69 (4.6)	65 (4.7)	30 (8.9)	19 (7.1)	16 (3.7)	16 (5.6)	16 (3.5)	19 (4.7)	7 (2.7)	11 (2.6)
Anxiety or depression	685 (23.8)	**285 (19.2)**	**400 (28.7)**	**85 (25.3)**	**89 (33.2)**	**89 (20.8)**	**87 (30.3)**	**69 (14.9)**	**112 (27.4)**	**42 (16.2)**	**112 (26.1)**
Dementia	104 (3.6)	**44 (3.0)**	**60 (4.3)**	0 (0)	0 (0)	5 (1.2)	<5	20 (4.3)	17 (4.2)	19 (7.3)	40 (9.3)
Smoking	64 (2.2)	**45 (3.0)**	**19 (1.4)**	20 (6.0)	10 (3.7)	19 (4.4)	7 (2.4)	6 (1.3)	<5	0 (0)	0 (0)

Data are reported as frequencies and percentages, except otherwise stated. Estimates with significant differences ($p \leq 0.05$) between sexes are highlighted in bold. TIA, transient ischaemic attack; IQR, inter-quartile range. [a]Unable to walk on admission used as a marker of severity of stroke/TIA event. [b]Traditional risk factors include hypertension, diabetes, atrial fibrillation, dyslipidaemia, and smoking. [c]Comorbidities were determined based on historical diagnoses prior to the stroke event from POLAR. [d]Cardiovascular disease includes coronary heart disease, coronary artery disease, myocardial infarction, peripheral vascular disease, and angina pectoris.

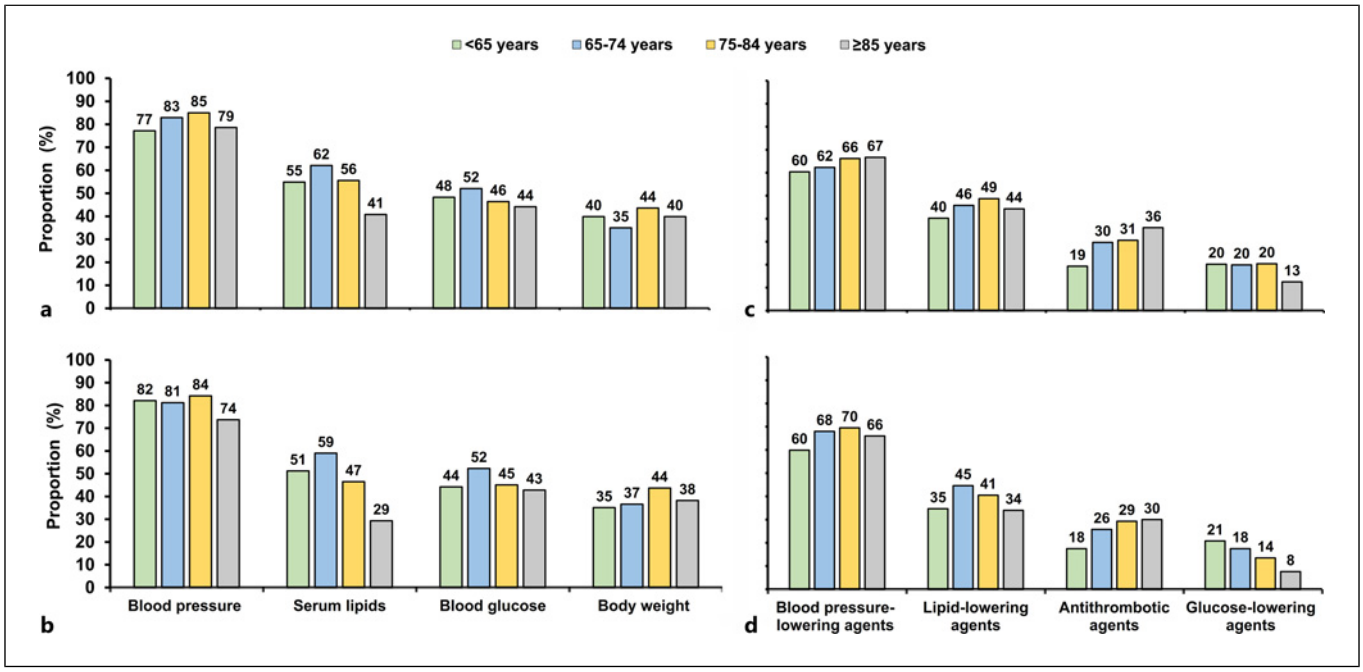

Fig. 1. Proportions of (**a**) men and (**b**) women assessed for risk factors by age group, and of (**c**) men and (**d**) women prescribed medications by age group. Estimates were adjusted for all variables listed in Table 1 and the cluster effect within general practices.

those aged <65 years, more men had their blood glucose assessed than women (44.2% for women vs. 48.3% for men). There were significant U-shaped relationships with increasing age and the number of risk factors assessed for both sexes, with this pattern more pronounced in women (Table 2).

Prescription of Medication among Patients with Indications

The most prescribed classes of prevention medication before stroke/TIA were BP-lowering agents (64.9%) and lipid-lowering agents (42.0%). In adjusted analyses, men were more often prescribed recommended medications

Table 2. Association between age and number of risk factors assessed and number of medications prescribed by sex

Age category	Risk factors assessed[a] IRR (95% CI)[c]		Medications prescribed[b] IRR (95% CI)[c]	
	men	women	men	women
<65 years	0.94 (0.86, 1.05)	0.97 (0.88, 1.07)	**0.82 (0.73, 0.92)**	**0.81 (0.71, 0.93)**
65–74 years	1.01 (0.93, 1.09)	1.05 (0.96, 1.15)	0.95 (0.87, 1.03)	1.02 (0.93, 1.11)
75–84 years	Reference	Reference	Reference	Reference
≥85 years	**0.89 (0.82, 0.98)**	**0.84 (0.79, 0.91)**	1.01 (0.93, 1.10)	0.92 (0.85, 1.01)

CI, confidence interval; IRR, incidence rate ratio. Estimates with significant values $p \leq 0.05$ are highlighted in bold. [a]Includes assessment of blood pressure, serum lipids, blood glucose, and body weight. [b]Includes lipid-lowering, blood pressure-lowering, antithrombotic (anticoagulant or antiplatelet), and glucose-lowering agents. [c]Estimates were obtained from Poisson regression model comprising all variables listed in Table 1 and the cluster effect within general practices.

than women, regardless of age group (shown in Fig. 1c, d). Patients aged <65 years were less often prescribed medications than older patients. There was a significant quadratic (U-shaped) trend with increasing age group in proportions of eligible women prescribed BP- and lipid-lowering agents (p value <0.05). In terms of the association between increasing age and the total number of classes of medications prescribed, a positive linear association was observed among men (odds least among those aged <65 years) and U-shaped association among women (odds least among those aged <65 and ≥85 years; Table 2).

Attainment of Risk Factor Targets

In the last measurement recorded within 12 months before stroke/TIA, only 2.4% of patients had all risk factors at target (1.7% when BP target was set at ≤130/80 mm Hg). For attainment of BP target, 62.3% of patients were within target at thresholds of ≤140/90 mm Hg, but reduced to 36.3% at thresholds of ≤130/80 mm Hg. Just 26.3% of patients had their body weight within target, and 18.8% attained targets for serum lipids. In the adjusted analysis, the proportion of patients achieving target for BP was generally greater among women than men (shown in Fig. 2). Among men, there was a significant increasing trend with older age in proportions of patients achieving targets for each of the risk factors (p value <0.001). In contrast, a significant quadratic trend was observed with increasing age in the proportion of women achieving targets for BP (at ≤140/90 mm Hg) and body weight. Specifically, among those aged <65 years, more women than men attained targets for BP (50.9% in men vs. 69.0% in women at ≤140/90 mm Hg; 29.7% in men vs. 34.6% in women at ≤130/80 mm Hg). Similar trends were observed for blood glucose (64.2% in men vs. 73.4% in women), and body weight (12.4% in men vs. 21.9% in women).

Discussion

Using real-world data, we provide evidence on the management of cardiovascular risk factors in Australian general practice for primary prevention in people who subsequently have a stroke/TIA. Specifically, we found that younger (aged <65 years) or older patients (aged ≥85 years) less often had their risk factors assessed or had recommended classes of prevention medications prescribed prior to their first-ever stroke/TIA than those aged 65–84 years, with this disparity more pronounced among women than men. In contrast, although attainment of risk factor targets was also generally worse among patients aged <65 years, women in this age group more often attained risk factor targets than men. The disproportionately worse management of risk factors among those aged <65 years is concerning given the increasing incidence of stroke/TIA in this younger population [2]. The considerably low proportion of people who attained targets for BP, serum lipids, and body weight within 12 months prior to their stroke/TIA highlight the current gaps in the management of cardiovascular risk factors in Australian general practice among those who subsequently

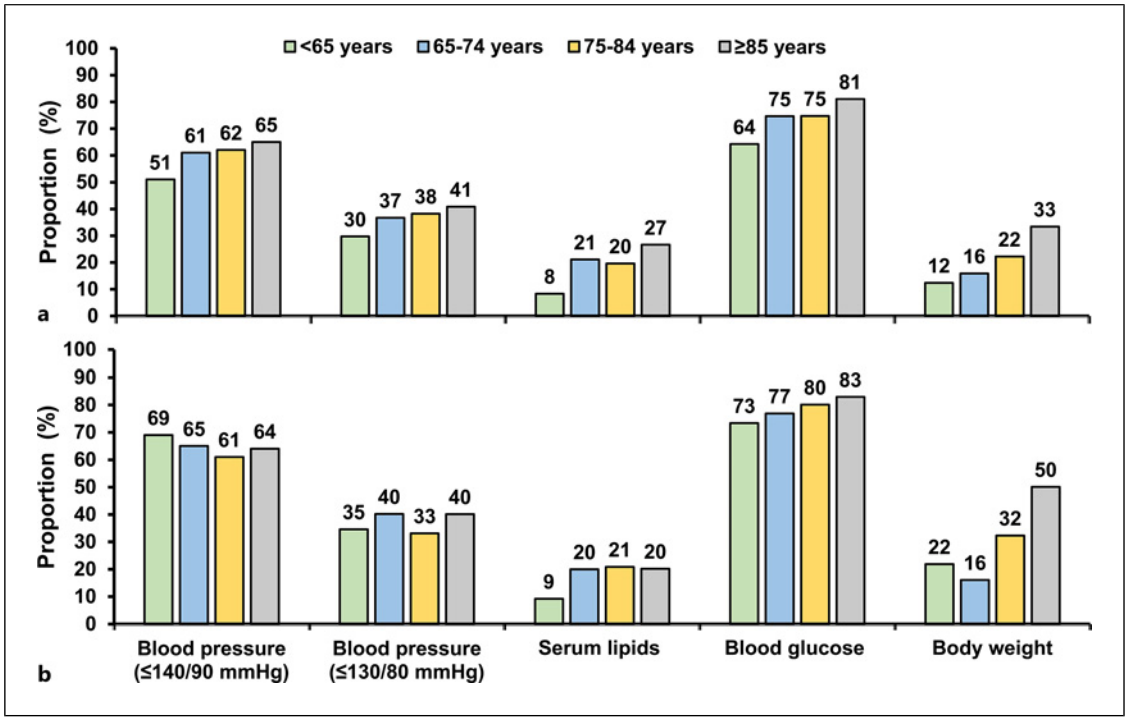

Fig. 2. Proportions of (**a**) men and (**b**) women who attained targets for risk factors, by age group. Estimates were adjusted for all variables listed in Table 1 and the cluster effect within general practices.

have a stroke/TIA. It is concerning that most people saw a GP within approximately 19 days of their stroke/TIA hospital admission.

Data on risk factor management in general practice, or any associated age or sex disparities, are scarce. This data linkage is the first example in stroke/TIA for Australia. Our findings on the sex difference in prescription of prevention medications are in contrast with those of 36,679 participants with no prior history of CVD in the UK, in which men and women had similar prescription patterns [19]. Persistent lower prescription of secondary prevention medication in women, compared to men, was previously reported among 8,278 stroke patients in Australia from 2012 to 2017 [20]. This was consistent with a study conducted in 2018 where authors reported a greater use of statins among men than women [21]. We now provide evidence that such disparity also exists in the prescription of primary prevention medication prior to stroke/TIA.

The significant U-shaped trend by increasing age in the prescription of prevention medications (BP- and lipid-lowering agents) was consistent with findings in a study of 1,203,290 adults in the Netherlands in 2010 [22] and a 2,002 audit of 321 general practices (n = 16,000 patients) in Australia [23]. In another study conducted across 19 general practices in the UK, authors reported a decline in lipid-lowering medications among patients aged >75 years than younger patients [19]. The disproportionately low prescription of medications in older patients may be due to contraindications or age-related intolerance to medications [19]. The reason for our finding of poor prescription of prevention medications among those aged <65 years is unclear and may be due to a perception that young people are at a lower risk of CVDs, including stroke. Further research is warranted to understand the prescription pattern and adherence to prevention medications among the younger population.

In a study comprising 7,641 patients from 12 European countries in 2009, authors reported that few patients aged <65 years attained targets for serum lipids [24]. This finding is consistent with that from a German study of adults aged 30–79 years with no history of CVD [25]. In our study, fewer than 10% of younger men and women attained targets for serum lipids. The lesser proportion of younger people attaining risk factor targets may be partly explained by the sub-optimal prescription of prevention medication, coupled with poor adherence to prevention medication among this age group [26].

Strengths and Limitations

We provide new information, using population-level general practice data, on disparities in the management of risk factors by age and sex in Australian general practice among those who subsequently have a stroke/TIA. Furthermore, linking data from general practices and the stroke registry provided complementary information to gain insights into the quality of care in the management of risk factors to prevent stroke/TIA. Our study is limited by the quality and completeness of data captured in general practice and the lack of complete capture of all general practices across the regions investigated. However, our study design ensured that regular use of participating practices was captured. In the stroke registry, data are not available on stroke aetiology (e.g., cardioembolic stroke from atrial fibrillation), as stroke characterisation is based on diagnosis assigned by a clinician (i.e., ischaemic stroke, intracerebral haemorrhage, TIA, or unknown type). In some circumstances, the aetiology can be derived using ICD-10 codes. However, these ICD-10 codes are not sufficiently reliable. In addition, most patients did not have records of important lifestyle risk factors (i.e., alcohol consumption, smoking), medication adherence, or reasons for not being assessed for risk factors or prescribed medications, which may have impacted risk factor management. Similarly, hospitalisations are common in the period leading to stroke/TIA [27], which could affect access to care. However, we did not have data on hospitalisations or other factors (e.g., socio-economic circumstances) that would have impacted the quality of primary care prior to stroke. Lastly, our analysis is focused on the management of individual risk factors rather than a measure of absolute cardiovascular risk.

In conclusion, we found considerable opportunities for improving the management of cardiovascular risk factors for primary prevention in general practice, particularly among younger people (aged <65 years) and women aged ≥85 years. These sub-groups of people may require additional support to ensure equitable, comprehensive care for preventing stroke/TIA in Australia. Future studies should be focused on understanding the underlying factors contributing to the identified gaps in the management of cardiovascular risk factors in general practice.

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Statement of Ethics

The AuSCR has ethics approval for an opt-out consent approach to recruiting registrants. In the information sheet for AuSCR participants, potential registrants are advised that data collected for the registry may be linked to other health data for research and monitoring purposes. Approvals for a waiver of consent to allow the linkage between AuSCR and POLAR data were obtained from the Monash University Human Research Ethics Committee (CF13/1303–2013000641) and the AuSCR Research Task Group.

Conflict of Interest Statement

D.A.C. is the data custodian for AuSCR. D.A.C., and M.F.K. are members of the AuSCR Management Committee. C.P. is the data custodian for AURORA. D.A.C. received restricted grants from Boehringer Ingelheim, Bristol-Myers, Moleac, and Medtronic and D.A.C. and M.F.K. from Amgen, outside the submitted work.

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Author Contributions

K.B. and M.T.O. conceptualised the study and undertook data analysis. K.B. prepared the first draft of the manuscript. M.T.O., M.F.K., and D.A.C. critically reviewed the first draft for intellectual content. J.K., M.F.K., M.T.O., and D.A.C. were responsible for data acquisition. All authors provided input in the interpretation of data, and approved the final version of manuscript.

Data Availability Statement

Patient-level linked data from this study cannot be shared due to ethical and legal restrictions. However, aggregated data and supporting coding of this study are available from the corresponding author.

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